

Digital Dilemmas:

Regulatory challenges for Artificial Intelligence and Machine Learning in medical devices and digital health products



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SOFTWARE FINANCE

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MANAGEMENT SUMMARY

The healthcare landscape is undergoing a profound transformation with the emergence of digital health technologies that leverage the data now available from an increasing range of sources including wearables, connected and smart medical devices.

This data is increasingly enabling the development of Artificial Intelligence/ Machine Learning (AI/ML) powered diagnostic and interventional tools. Regulatory bodies, such as the FDA and MHRA, are making strides in defining and regulating AI/ML-enabled medical devices, with a focus on ensuring safety and efficacy.

Despite this progress, navigating the evolving regulatory landscape poses challenges, especially as digital health solutions can blur the lines between medical devices and non-medical tools. AI and ML offer immense potential in revolutionizing healthcare delivery, enabling early disease detection, personalized treatment approaches, and remote patient monitoring to name a few.

However, regulatory scrutiny varies across regions, with new regulations like the EU AI Act introducing additional complexities.



Collaborating with regulatory experts and embracing multidisciplinary approaches are crucial for navigating these challenges and ensuring compliance with evolving standards. By leveraging expertise and forstering collaboration, innovators can drive the development of transformative digital health solutions while addressing regulatory complexities.



INTRODUCTION

The healthcare landscape has embarked on a new era with the advent of digital health technologies. From wearable sensors that monitor vital signs to AI-powered diagnostic tools, the range of innovations is vast and promises to revolutionize healthcare delivery.



Reports show that as of May 2024, the FDA had listed 882 approved AI/ML-enabled medical devices.[1]

The FDA has in fact made great strides in the direction of defining and therefore regulating AI/ML-enabled devices and has gone so far as to compile a publicly available list of such tools which, however, is not designed to be comprehensive.

Among these it is clear that radiology has both the largest number of submissions and that it is showing the steadiest increase of AI/ML-enabled device submissions. Interestingly, algorithmic models can be seen to be increasing in complexity, with more and more featuring deep learning models. [3] On the other hand, hybrid models, combining multiple different algorithmic approaches, continue to dominate within the medical devices assessed by FDA. [4]

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As the industry embraces these advancements, regulatory bodies the world over are grappling with the complexities of evaluating and approving medical devices that do not conform to traditional paradigms and do not have a physical presence in the traditional sense. AI holds immense promise in revolutionizing healthcare delivery by facilitating early disease detection, personalized treatment approaches, and augmenting remote consultations through telehealth solutions.



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AI holds immense promise in revolutionizing healthcare delivery by facilitating early disease detection, personalised treatment approaches and augmenting remote consultations through telehealth.



AI-powered algorithms can analyse vast troves of health data to identify disease biomarkers, predict disease trajectories, and tailor interventions to individual patients. Regulators are thus striving to keep pace with technological advancements, while addressing concerns regarding data security, potential bias and safety impacts possible from poorly performing clinical software tools, that underscore the need for robust regulatory frameworks such as the EU AI Act which has been designed to regulate AI across a range of sectors, including healthcare.

One effort to help simplify the confirmation of clinical efficacy and safety for AI systems has been offered by the UK, where a new regulatory sandbox, announced in November 2023, has been designed to provide a safe space for AI tool developers in healthcare to trial products in view of regulators before they are implemented.[5].

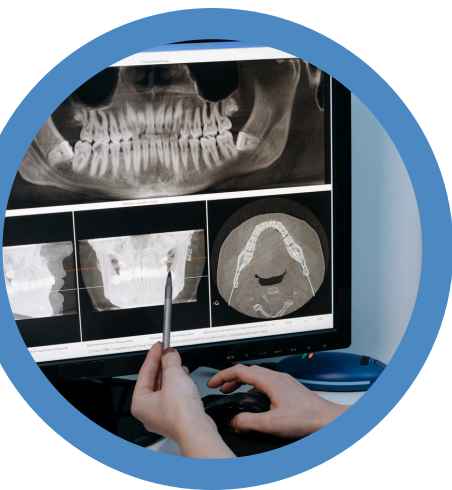
In this whitepaper, we delve into the evolving regulatory landscape, focusing on the challenges and opportunities presented by the use of AI and ML in digital health technologies.

UNLOCKING THE POTENTIAL OF AI

While concerns around potential harm and bias are beginning to outline possible confines within which AI/ML can be employed and with what degree of human intervention, more and more AI/ML tools are being developed in the healthcare sector to help manage vast amounts of data and interpret it speedily and accurately. Whether this data is in text form (such as notes), video or imagery, AI/ML can help save hours of manual analysis and cross-checking and suggest interpretation that would otherwise take human researchers years to complete. AI/ML can rapidly analyse radiology images, histological data, posture, eye movement, speech speed, pitch and sound and a whole range of other types of input.



Some example areas for application of AI/ML within medical devices are:



Diagnostic Imaging

AI and ML algorithms are used to analyse medical images such as X-rays, MRI scans, CT scans, and ultrasounds to aid in the diagnosis of various conditions. For example, detecting abnormalities in radiology images, identifying and grading tumours, or assessing the progression of certain neurological diseases through analysis of brain imaging.

Remote Patient Monitoring

AI-powered medical devices can continuously monitor patients remotely, collecting data on vital signs, activity levels, and other relevant metrics. This enables early detection of health problems and allows for timely intervention, especially for chronic conditions such as diabetes, heart disease, or respiratory disorders.



Personalized Medicine

AI/ML algorithms analyse patient data, including genetic information, medical history, and lifestyle factors, to personalize treatment plans. This can involve predicting how a patient will respond to certain medications, identifying optimal dosages, or recommending specific therapies tailored to individual characteristics.

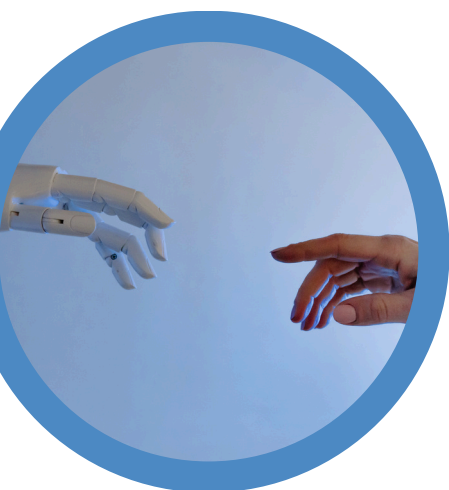


Clinical Decision Support Systems (CDSS)

These systems provide healthcare professionals with evidence-based recommendations and guidance at the point of care. AI/ML algorithms analyse patient data, medical literature, and clinical guidelines to assist in diagnosis, treatment planning, and decision-making.

Wearable Health Devices

Wearable devices equipped with AI/ML capabilities can monitor various health parameters, such as heart rate, blood pressure, sleep patterns, and physical activity. These devices provide real-time insights into a person's health status and behaviour, enabling proactive management of chronic conditions.



Robotic Surgery

AI-powered surgical robots assist surgeons during minimally invasive procedures by enhancing precision, dexterity, and control. These systems can analyse real-time feedback from surgical instruments and imaging devices to optimize surgical outcomes and reduce complications.



Predictive analytics for Healthcare Management

AI and ML models analyse large volumes of healthcare data, including electronic health records, insurance claim data, and operational metrics to identify patterns, trends, and risk factors. This information helps healthcare organizations improve resource allocation, optimize workflows, and implement preventive interventions to enhance patient outcomes and reduce costs.

These application areas demonstrate the versatility and potential impact of AI and ML in medical device development and healthcare delivery, spanning from diagnosis and treatment to patient monitoring and management.

In underfunded areas of medical research, this could even prove life changing by helping detect comorbidities, environmental or genetic factors that place particular individuals at higher risk of disease. Moving the bar even higher than early detection, it could become possible to warn people of an estimated potential risk years before diseases begin to manifest.

DIGITAL HEALTH PRODUCTS VS. DIGITAL MEDICAL DEVICES

The amount of regulatory scrutiny an app or software is subject to largely depends on whether the AI/ML tool actually is a medical device or not. The delineation between digital health and digital medical devices, however, is not always simple, and it is crucial to understanding regulatory nuances. Digital health encompasses a spectrum of technologies, ranging from non-medical devices designed to monitor well-being to medical devices tailored for specific medical purposes. The many mindfulness apps, sleep tracking devices and many other apps flooding the internet, for example, are not medical devices.

A change in a single word of a marketing claim can sometimes be the difference between a product being a digital health product or being regulated as a medical device.

Notably, software tools aimed at assessing risk and disease states for population cohorts fall outside the purview of medical devices, highlighting the intricacies of classification in the digital health landscape.



A consensus, but not exhaustive, definition for “Software as a Medical Device” is provided by the International Medical Device Regulators Forum (IMDRF), which describes it as:



Software intended to be used for one or more medical purposes that perform these purposes without being part of a hardware medical device.



The room for interpretation, however, is uncomfortably broad, and doesn't preclude use of AI/ML algorithms in medical devices with integrated processing hardware.

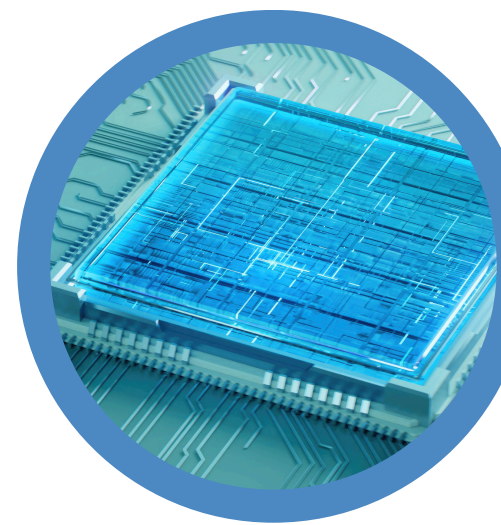
In its June 2023 Roadmap, the MHRA confirmed it is developing guidance to help clearly identify Software as a Medical Device (SaMD) differentiating them from that wide and confusing range of other tools such as wellbeing and lifestyle software products, IVD software and companion diagnostics. Guidance will also offer requirements that might apply to 'in house' SaMD used by hospitals, to a research use only 'exemption' for SaMD, to custom made devices, to software in a kit / software system / software in procedure pack / software as a service, accessories to a medical device or IVD and devices with no medical function.[6]

As the volume of health data proliferates, the development of software-based medical devices is accelerating, prompting manufacturers to grapple with varying definitions and regulatory requirements across regions.

NAVIGATING REGULATORY CLASSIFICATION

The EU has published a proposal for a wider AI Act which will also encompass medical devices. The proposal aims to “ensure consistency and avoid unnecessary administrative burden or costs” for providers of a product that contains one or more high-risk artificial intelligence systems and describes:

“ AI systems identified as high-risk should be limited to those that have a significant harmful impact on the health, safety and fundamental rights of persons in the Union[7]. ”



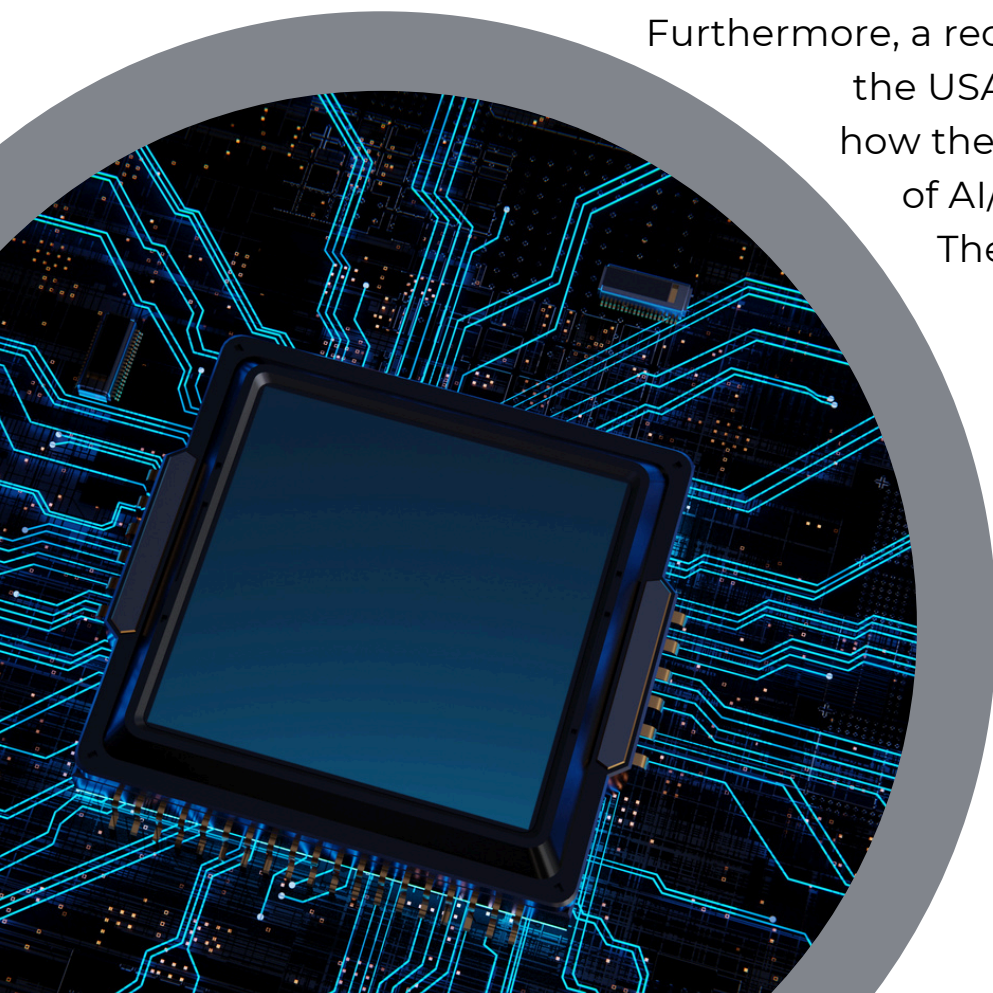
The proposal specifies: “in the health sector where the stakes for life and health are particularly high, increasingly sophisticated diagnostics systems and systems supporting human decisions should be reliable and accurate. The extent of the adverse impact caused by the AI system on the fundamental rights protected by the Charter is of particular relevance when classifying an AI system as high-risk.” [8]

The legislation also specifically calls out certain digital health technologies as being high risk; for example AI systems which are used for emergency healthcare patient triaging and systems used in evaluating eligibility for certain healthcare services.

These are classified as high-risk “since they make decisions in very critical situations for the life and health of persons and their property.” [9]

In Europe, medical device software incorporating AI or machine learning currently typically falls under Class IIa classification at a minimum and requires formal regulatory assessment. However, the EU AI Act introduces additional complexities, potentially augmenting regulatory scrutiny for AI-based medical devices.

As a result, rather than in compliance with medical device requirements, certain digital health products may also come under CE marking regulation for the first time under AI Act regulatory assessment of high risk AI systems. These digital health products will therefore now require notified body assessment, which, however, will be based on different criteria from existing requirements for medical devices.



Furthermore, a recent Executive Order in the USA is expected to impact how the FDA regulates the use of AI/ML in medical devices. The FDA currently applies its “benefit-risk” framework and confirms that they must conform to some basic principles such as the demonstration of sensitivity and specificity for devices used for diagnostic purposes,

the validation of intended purpose and stakeholder requirements against specifications and development that ensures repeatability, reliability and performance. The FDA have also considered the need for some AI/ML systems to be adaptively re-trained on new data or context specific data, and so have introduced pilot processes to enable certain pre-authorised software changes to be agreed by the manufacturer and the FDA which can then be deployed without the need for further regulatory assessment.[10]

This is a significant milestone in regulatory innovation, as traditional assessment methods still used in EU medical device assessments can struggle to enable similar effective and proportionate regulation.

To respond to a need to keep pace with evolving ML methods and applications, the MHRA will develop a system based more on guidance than regulation in the UK, allowing for more frequent updates. Alongside the FDA and Health Canada the MHRA has outlined 10 guiding principles that can inform the development of Good Machine Learning Practice (GMLP) that are safe, effective, and promote high-quality medical devices that use artificial intelligence and machine learning (AI/ML).



The ten points are:

- 1.** Multi-Disciplinary Expertise Is Leveraged Throughout the Total Product Life Cycle
- 2.** Good Software Engineering and Security Practices Are Implemented
- 3.** Clinical Study Participants and Data Sets Are Representative of the Intended Patient Population
- 4.** Training Data Sets Are Independent of Test Sets
- 5.** Selected Reference Datasets Are Based Upon Best Available Methods
- 6.** Model Design Is Tailored to the Available Data and Reflects the Intended Use of the Device
- 7.** Focus Is Placed on the Performance of the Human-AI Team
- 8.** Testing Demonstrates Device Performance during Clinically Relevant Conditions
- 9.** Users Are Provided with Clear, Essential Information
- 10.** Deployed Models Are Monitored for Performance and Re-training Risks are Managed

In 2023, the MHRA also updated the Software and AI as a Medical Device Change Programme, to ensure regulatory requirements for software and AI are clear and patients are protected. This programme builds upon wider reforms for medical devices and innovation such as the Medical Technology Strategy Report (2023) and a £30 million investment in innovative technology for the NHS.

The Change Programme specifically builds on the intention to make the UK a globally recognised home of responsible innovation for medical device software. Three main areas of focus to achieve this are:

- 1.** Safety assurances
- 2.** Clear guidance and processes for manufacturers to follow
- 3.** Liaison with key partners such as the National Institute for Health and Care Excellence (NICE) and NHS England but also with international regulators through the International Medical Device Regulators Forum (IMDRF)

In a bid to address bias and inequalities, the MHRA also confirms that it recognises that SaMD and AIaMD must perform across all populations within the intended use of the device and serve the needs of diverse communities.



CONCLUSION: EMBRACING COLLABORATION AND EXPERTISE

As the digital health landscape continues to evolve, collaboration with regulatory experts will support manufacturers that need to navigate the intricacies of developing digital medical devices within changing global regulatory frameworks.

Right from the initial steps of device development, when market demand is assessed and tools are initially developed, it is critical to have a clear understanding of the objectives, risks and potential of the tool across different markets.

Given the heightened complexity of AI-based medical devices and digital health products, it is imperative to discern whether AI/ML functionalities are integral to product functionality or serve as supplementary components, and how this could impact decisions on fundamental product architecture, software algorithm design and regulatory evidence generation strategy.

Partnering with professionals who possess in-depth knowledge of regional regulations and emerging trends in digital health can expedite market entry and ensure compliance with evolving standards and requirements. By embracing collaboration and expertise, innovators can navigate regulatory challenges and pave the way for transformative digital health solutions.



REFERENCES

[1] Electronics, [FDA-Approved Artificial Intelligence and Machine Learning \(AI/ML\)-Enabled Medical Devices: An Updated Landscape](#), by Geeta Joshi, Aditi Jain, Shalini Reddy Araveeti, Sabina Adhikari , Harshit Garg and Mukund Bhandari, 24th January 2024

[2] [FDA, Artificial Intelligence and Machine Learning \(AI/ML\)-Enabled Medical Devices](#)

[3] [FDA, Artificial Intelligence and Machine Learning \(AI/ML\)-Enabled Medical Devices](#)

[4] [FDA, Artificial Intelligence and Machine Learning \(AI/ML\)-Enabled Medical Devices](#)

[5] [Gov.co.uk, MHRA to launch the AI-Airlock, a new regulatory sandbox for AI developers, 1st November 2023](#)

[6] [Gov.co.uk, Software and AI as a Medical Device Change Programme – Roadmap, June 2023](#)

[7] [EUR Lex, Proposal for a Regulation laying down harmonised rules on artificial intelligence, \(27\)](#).

[8] [EUR Lex, Proposal for a Regulation laying down harmonised rules on artificial intelligence, \(27\)](#).

[9] [EUR Lex, Proposal for a Regulation laying down harmonised rules on artificial intelligence, \(37\)](#).

[10] [FDA, Marketing Submission Recommendations for a Predetermined Change Control Plan for Artificial Intelligence/Machine Learning \(AI/ML\)-Enabled Device Software Functions Draft Guidance for Industry and Food and Drug Administration Staff APRIL 2023](#)

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